Athlete with pacemaker or cardioverter-defibrillator

Original Title: Sportovec s kardiostimulátorem či kardioverterem-defi brilátorem

Authors: Otakar Jiravskýa, Bogna Jiravská Godulaa, Jan Chovančíka,
Radim Špačeka, Libor Škňouřila and Martin Fialab

Introduction

We implant a permanent pacemaker (TCS) in the patient to reduce the risk of sudden cardiac death due to circulatory arrest and / or to alleviate the symptoms of bradycardia – weakness, dizziness, inefficiency, presyncope or syncope. Implantable cardioverter-defibrillator (possibly subcutaneous cardioverter-defibrillator) briller [S-ICD]) is indicated to the patient in order to reduce the risk of sudden cardiac death in malignant ventricular arrhythmia. In some patients, in relation to their diagnosis, we also use the stimulation options of an implantable cardioverter-defibrillator (ICD), including biventricular pacing (BIV ICD) . It is an undeniable fact that patients with TKS, ICD, S-ICD, BIV ICD want to experience benefits of physical activity, often bordering on dependence on endorphins, which intense physical activity brings. The role of a cardiologist is to be a guide and protector of the athlete, to adequately achieve such a degree of education in the form of a joint agreement that the athlete will not want to carry out activities beyond acceptable risk, not a dominant patriarchal "forbid" of everything. It is not a one-time activity, in this case a long-term doctor-patient bond must be established, as the implant remains a part of the athlete's life for a long time, often for life. A cardiologist/arrhythmologist who cares for an athlete with an implanted system must have a special understanding of the athlete's specific mental setting. The cardiologist, optimally a sports cardiologist, cares for the athlete in collaboration with a range of other specialties. Perhaps the most important factor determining the further development of the patient's condition with the implant is education. The Athlete must be as educated as possible in TKS / ICD / S-ICD / BIV ICD to avoid complications. From the point of view of sports, it is mainly an injury in the area of the generator due to external forces and the risk of damage to the electrodes by long-lasting repetitive movement of the limbs in the shoulders and the possible need for regular medication resulting from the underlying disease. An important knowledge is a basic understanding of the functioning of the implanted system and its interaction with externally induced conditions. The medical fitness of a patient with an implanted system depends on the presence of the implant, but at the same time must respect the limitations of basic cardiovascular disease.

Indications for implantation in athletes

Indication criteria for TKS implantation in athletes do not differ from the general population, they are based on the treatment of clear symptoms caused by any bradycardia and the prevention of sudden cardiac death or syncope in the so-called advanced atrioventricular (AV) block. The physician indicating TKS to athletes must always take into account the significant vagotonia of the athlete due to cardiovascular training and distinguish only the so-called functional changes from the pathology. However, in addition to accentuated vagotonia, long-term athletes also experience functional-structural changes in the sinoatrial node, such as decreased expression of HCN4 channels. Indication criteria for ICD implantation in athletes do not differ from the general population, it should be explicitly emphasized that it is not possible to consider implantation of ICD in some nosological unit in order for the athlete to continue to perform. There is a need to share information and joint decision of cardiologist and athlete further procedure before and after ICD implantation. The choice of the type of device should be a part of this joint discussion. For some sports, an S-ICD may be a better alternative for a different generator location, for a different electrode course. It should be noted, however, that the above arguments are not yet supported by robust data. The indication discussion must also take into account the type of sport. It is necessary to determine the side of implantation in advance (taking into account repetitive movements of the upper limb of the side – eg racquet sports, possibly shoulder load – axillary landscapes – eg shooting) . It is also necessary to take into account the condition of the subcutaneous tissue at the site of potential implantation to discuss the benefits and risks of implanting the generator under the pectoral muscle, not on its fascia subcutaneously. In the indicative interview of the cardiologist with the athlete, the requirements for the type of generator must also be heard. It is necessary to discuss hardware options (eg types of motion sensors of individual manufacturers, shape and size of the generator,

long-term mechanical resistance of implanted electrodes, MR compatibility of the considered system) and software superstructures (mainly the possibility of home monitoring).

Return to sports activities after implantation

After implantation of TKS / ICD / S-ICD / BIV ICD, the athlete is asked to suspend sports activities until the whole system is fully healed, including the fixation of electrodes in the heart. This generally takes about 4-6 weeks. After the end of the initial phase of healing comes another phase, when the athlete gradually increases his workload for evaluating their acceptance and tolerance. There are necessary regular checks of the software settings of the implanted system in an effort to optimize all functions tailored to the athlete, type of sport, underlying disease, heart disease, especially the typology of the transmission system. In addition to software optimization, the medication is gradually adjusted in the following period. The athlete must approach any adjustment to medication with humility and openness, especially changes in bradycardizing medication changing his habits and personal knowledge of training. In the first three months after the start of sports activities, the athlete switches from training in heart rate zones below the anaerobic threshold and gradually increases them to the lengths and intensities determined by the team consisting of coach, physical education doctor, sports cardiologist, arrhythmologist (or biomedical engineer). During this period, the athlete with the pacemaker must know the responses of his pacing system to the load, must know the heart rates that his pacing system can generate in response to the type of exercise, must know the maximum heart rates of the allowed atrial transmission. In addition, an athlete with a defibrillator must know the defibrillation zones, play sports with a heart rate monitor, and be sure that he or she does not reach the heart rates of the defilation zones. Here it is the responsibility of the cardiologist / sports cardiologist / physical education physician to determine and communicate fitness for sport, ev its conditions.

Implant area

The athlete will most often have an implanted system generator subclavicularly to the left or right, subcutaneously or subpectorally. The S-ICD is then placed in the mid axillary line above the anterior serratus muscle. Generators implanted during childhood can be located in the left hypogastrium. The sizes of the generator and the electrodes located below it are between 50-150 mm. The entrance incision site is scar healed. The scar itself does not have as much resistance to stress as the original skin cover. The location of the generator then reduces this resistance of the scar and skin cover. Repeated incisions of the scar during reimplantation of the generator to deplete the source can further aggravate the situation. A mechanical blow to the generator area, even blunt, even through clothing, can cause tissue injury above the generator with subcutaneous hematoma, non-infectious necrosis of the skin and subcutaneous tissue. This risk is highest in sports classified as contact sports, in Mitchel's classification of 'danger of body collision'. Special protection materials have been developed to be inserted into a special harness or directly into / under clothing above the generator area to distribute the forces acting (e.g., Vital Beat © – fig. 1, PACEGUARD © – fig. 2). These protection systems have not yet been substantiated by more fundamental records, only by company mechanical-physical studies. As we are unlikely to see randomised studies in this area, the recommendation for their use will be unambiguous, but only at the level of expert consensus.

Stimulation electrode, defilation

Mechanical damage to the stimulation electrodes, especially in the area of the passage between the collarbone and the rib, occurs in the non-sporting population with an incidence between 1-3% per year (but higher at the Sprint Fidelis [Medtronic] and Riata [St. Jude Medical] electrodes). Risk factors are considered to be medial lead entry into the subclavian vein (preferably some data present a lower risk of lead fracture during trans cephalic implantation), 12 small space between the collarbone and rib, sharp angle of lead entry into the vein, large electrode bend under the generator.13 As a clear risk factor for lead fracture is shown to be lower age, male gender and good left ventricular ejection fraction (EF LK), suggesting that higher physical activity in patients with normal cardiac function may be a burden to the lead. There are concerns that long-term repetitive limb movements during sports activities, such as rowing or strengthening, will increase the risk of electrode damage, as confirmed by some published data on athletes, where electrode damage was observed in 7.7% over five years and in 20, 4% in ten years.14 The role of a sports cardiologist is in choosing a sports discipline that is more suitable for athletes with an implanted system. Special care must be taken to

ensure that sports fitness recommendations refer athletes with cardiovascular diagnoses to the Mitchell Class IA sports category. However, there are sports with a dominantly repetitive movement of the limbs (bowling, cricket, golf) and shooting, where it is necessary to consider the possible support of the stock of the weapon. In the case of an indication of ICD implantation in an athlete without the need for stimulation, it is possible / appropriate to consider S-ICD implantation, where the risk of electrode damage has not yet been significantly described in athletes.

Interactions of the cardiovascular system and the implanted system under load in relation to the setting of individual parameters

Once implanted, the stimulation / defibrillation system is not a rigid structure that is stable and independent of external conditions. Conversely, software variability allows the athlete to optimize the system. However, this optimization process requires knowledge of the sports discipline of the cardiologist, knowledge of the specification of the athlete's disease, precise knowledge of the cardiovascular history and, finally, a deep knowledge of the implanted system. The athlete must provide targeted feedback as part of the system optimization process. The majority of the population that is implanted with the systems is unsportsmanlike, so the production setup of these products is aimed more at the passive population and requires a number of changes for athletes. Each athlete requires individual targeted settings of basic as well as advanced functionalities.

Motion sensor settings
A motion sensor is a hardware device that allows you to change settings while moving. Each manufacturer and each product has its own specifics and it is necessary to get acquainted with it. All current sensors include an accelerometer that evaluates the "mechanical shocks" of the system. Furthermore, this sensor can be combined with a minute ventilation sensor. Rarely we encounter a sensor measuring changes in QT interval, temperature, impedance, or chest movement. The sensor can be switched off / on. When the sensor is turned off, the pacing system does not respond to movement. The on sensor then regulates the pacing rate. It programs a sensitivity threshold – a measure of the "shocks" that activate the sensor. It regulates the speed at which the sensor evaluates that physical activity has begun (not, for example, only rolling from side to side in bed). We set the rate of acceleration of the heart rate – i.e., the time in which it reaches the maximum sensor rate during the duration of physical activity. Finally, the rate of slowing of the heart rate at the end of physical activity. This setting is easier for runners, on the contrary very difficult for cyclists (there are not many shocks) or riders on horseback (there are significant shocks of inadequate physical exertion). The setting for combined sports (e.g. triathlon, multi-combat) is a way to compromise.

Setting maximum heart rates stimulation
Athletes must also adjust the maximum heart rate at which the sensor accelerates the heart rate and the maximum heart rate that the pacemaker senses in the atrium to ventricular pacing. The usual factory setting of these frequencies of approximately 130 / min will not satisfy the athlete. There are data showing the long-term safety of setting these frequencies to 180 / min for a pacemaker.15 The above settings allow the cardiologist, in collaboration with a clinical engineer and company representative, to adjust other advanced features, such as post ventricular atrial refractory. period, PVARP), auto mode switch (AMS) and many more. It is advantageous to perform the optimization of the stimulation system settings directly on the sports ground of the athlete with targeted tuning. Sports cardiology departments can offer this service.

Setting up treatment zones for ventricular arrhythmias
It is the task of the cardiologist-arrhythmologist to set the heart rate zones from which the defibrillator considers treatment for ventricular arrhythmias. It is based on the heart rate of the slowest captured ventricular arrhythmia. Low settings of ventricular arrhythmia heart rate zones can lead to an increase in inadequate shocks in sinus tachycardia in sports or atrial arrhythmias. There are data demonstrating the safety of setting higher frequencies and longer duration of this heart rate in athletes. Only two athletes experienced a ventricular arrhythmia below the therapeutic zone, without syncope, with only palpitations.16 This study on the setting of athletes' ICDs is consistent with a study with a similar approach in the general population.17 The

athlete must be as educated as possible about ICDs to avoid complications. It is important to know that the decision to play sports with an ICD is associated with a good prognosis but carries approximately twice the risk of adequate and inadequate shocks. In the event that an athlete experiences a so-called shock, he should not continue sports activity at the moment. The athlete should be reassured, fluids, ions replenished, medication used checked, and the ICD checked as soon as possible to determine whether the therapy was so-called inadequate, along with a decision on how to proceed with the sport. Knowledge of the set zones of ventricular arrhythmias ICD, S- -ICD is an essential knowledge of the athlete. An athlete with an ICD, S-ICD must play sports with a heart rate monitor. Achieving heart rates close to the ventricular arrhythmia treatment zone settings should be avoided and should be kept at least 10 / min below this zone. Regular use of prescribed medication, especially beta-blockers, is key in preventing adequate and inadequate shocks.18 The rebound phenomenon after skipping / abruptly discontinuing a dose of beta-blockers is a typical precipitating factor for ICD shock, especially in long QT syndrome (LQT) .19

Athlete stress testing with implanted system

The real specialty is the indication and performance of a stress test on an athlete with TKS. They must respect the indications for TKS implantation, knowledge of the type of pacemaker, TKS setting parameters – especially the sensor settings and conversion parameters. It is very suitable to perform stress tests on athletes with TC in the center with knowledge of sports cardiology and cardiac electrophysiology, optimally with the so-called programmer during the test. Exercise testing of an athlete with an ICD can only be performed with knowledge of ICD programming. Each ICD has programmed heart rate zones from which it runs diagnostics and ev. follow-up therapy, ventricular arrhythmias. And it is precisely these higher heart rates that a patient with an ICD should not approach without the possibility of an immediate reaction, without the presence of a cardiologist with a programmer (a device capable of changing the software settings of the ICD).

Medical fitness for sport with implanted system

Fitness of an athlete with pacemaker

An important data for athletes is the so – called dependence on stimulation. If the athlete has no heart rate of his own action and loses consciousness in the event of a sudden failure of the TKS function marked as dependent. There is some inconsistency in fitness for sport between the current US20 and European recommendations, 21 in summary:

1. American and European best practices agree that the mere presence of a TKS should not disqualify an athlete from racing: that an assessment is necessary in the context of heart disease itself and symptoms leading to TKS implantation.
2. European guidelines recommend allowing only sports from group I / A, B Mitchell classifications. US best practices determine eligibility based on stimulus dependence. Dependent patients must not compete in contact sports (damage to TCS would lead to serious symptoms /death). Independent patients without structural heart disease may also be eligible for contact sports with personal acceptance and understanding of the risk of TCS damage.
3. European recommended procedures draw attention to the need for cardiological dispensarization with ECG, exercise testing, echocardiography and require necessity absence of atrial arrhythmias and evidence of heart rate increase frequency under load. They also point out the need for assessment of the risk of electromagnetic interference athlete's environment and TKS.
4. American guidelines recommend considering use protective elements / protective clothing per area generator when participating in contact sports.

Fitness of an athlete with an ICD, S-ICD

Recommendations on fitness for sport (general, given by the presence of an ICD; to be eligible recommendations must also be taken into account with regard to primary heart disease):

1. American and European best practices alike mention that the indications for ICD implantation do not differ in athletes from those for non-athletes. In American the best practices add that part of the indicati-

on process should be a discussion with the athlete about the limitations of the presence of ICD in life and sport will bring.

2. European best practices draw attention to the fact that implantation of an ICD does not disappear the arrhythmic substrate, on the contrary it may be more affected by high sports load, however, with the effect that the ICD provides sudden prevention of heart death.
3. American best practices approve sports activity in sports classification IA (golf, shooting, bowling, cricket, yoga) under conditions of three months absence ventricular arrhythmias. For sports with a higher static and dynamic component than IA, there is eligibility possible under conditions of three-month absence of ventricular arrhythmias and understanding / accepting the fact that in these sports, the athlete is exposed to many times higher frequency of adequate and inadequate ICD shocks.
4. European best practices state that the award eligible athletes with ICD must be on an individual basis with respect to the primary disease (e.g. arrhythmogenic cardiomyopathy or catecholaminergic polymorphic ventricular tachycardia is an absolute contraindication), with caution as in the US best practices to a higher probability frequency of adequate / inadequate shocks, taking into account the risk of injury / damage to the ICD in contact sports (here European best practices specifically they exclude sports such as rugby, American football and martial arts, in other contact sports they state suitability for use of protective equipment / protective equipment clothing above the ICD generator), taking into account the risk electrode damage in repetitive arm movements on the implantation side.
5. European best practices further mention that ICD holders may not engage in sports where a sudden loss of consciousness can lead to the risk of death, such as climbing, surfing, motorsports or deep-sea diving.
6. The US Best Practices explicitly state that the athlete should not opt for ICD implantation so that he can continue in the sport.

The European guidelines will be updated in the course of 2020. In the context of Czech legislation, there is the concept of a medical fitness report. It is based on Act No. 373/2011 Coll. for specific health services, as amended by the Decree on Medical Fitness for Physical Education and Sport, No. 391/2013 Coll. According to the law, this opinion can be issued by a general practitioner for adults or children and adolescents or a physical education doctor for top and performance athletes, and only a physical education doctor for top athletes. The role of a cardiologist or sports cardiologist is to provide information about the athlete's cardiovascular status to the report. The cardiologist / sports cardiologist should comment on the fitness for sport from the cardiologist's point of view, possibly defining the conditions under which, from his point of view, the assessment could be considered.